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ABSTRACT

This paper describes the development of a fully online Master's program in science education that is intended to help teachers extend their science knowledge and integrate inquiry-based science pedagogy and Web-based technologies into their teaching. Courses are co-taught by a scientist well-versed in the science domain of a given module and a science educator. The instructors facilitate online discussion and serve as mentors and coaches. Try Science, the introductory course, focuses on the scientific method of inquiry and science pedagogy. All courses include both science and pedagogical strands, with a different instructor for each strand. In the science strand, participants receive a kit of materials for setting up labs at home. They explore scientific concepts through hands-on investigations, collect qualitative and quantitative data, post the results of their investigations, and participate in discussions online. In the pedagogical strand, participants consider specific issues of teaching and learning by reflecting on their experiences in their science study and learning about alternative strategies for planning, facilitating, and assessing inquiry-based science (via videos, case studies, and reading and discussion). They also design and implement plans for the classroom. The instructor's role is to focus on individual students' learning and on collaborative learning. (SM)

# Emerging Faculty Role: Teaching for Deep Understanding Online

Susan J. Doubler, Linda Grisham, and Katherine F. Paget

January 26, 2003

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## Introduction

University faculty who teach postsecondary courses online have an unprecedented opportunity to strengthen the learning of their students by placing *understanding* at the center of their teaching. How do we take advantage of this opportunity? What does it mean to teach for understanding online? What are the implications for instruction?

## Taking Advantage of New Realities

Online distance education is becoming an established part of postsecondary education. Between 1995 and 1998, the percentage of higher education institutions that offer online courses increased by approximately 30 percent (National Center for Education Statistics, 1999). Given this prodigious increase in online course offerings, there is a pressing need for strategies and models to help faculty teach effectively "at a distance."

Faculty frequently ask, "Can I be an effective online teacher? How should I communicate with my students online? How will I know that they are learning?" A growing literature targets these questions, (Palloff & Pratt 1999, Ko and Rossen 2000, White and Weight 2000, Harasim et al 1997, Collision, G., R. Tinker, B. Elbaum, S. Haavind, 2000). Much attention is given to how discussions are facilitated and communities of learning established, and the reflective nature of the online environment.

Understandably, much of our current knowledge derives from online teaching experiences and case studies (Wiesenberg 1999).

Few studies look in-depth at the learning of domain-specific knowledge and the online instructor's role in furthering this knowledge. Our current work, to develop a fully online Master's program in science education, is giving us the opportunity to rethink the faculty role.

## Overview of the Science in Education Master's Degree Program

Lesley University and TERC, are collaborating on the development of an online master's program, Science in Education (33 credits) at Lesley University, Cambridge, MA, for K-8 educators. This program is designed to help teachers extend their science knowledge, integrate inquiry-based science pedagogy and web-based technologies into their teaching. *Try Science*, the introductory three-credit graduate level course, focuses on the scientific method of inquiry and

science pedagogy. The development of *Try Science* and other courses in the program (physics, biology, earth science, ecology, and engineering), as well as an accompanying research study are funded by the National Science Foundation (NSF) #ESI 9911770 and U.S. Dept. of Education, Fund for the Improvement of Postsecondary Education (FIPSE) #P116D990066.

Courses are taught by a scientist well versed in the science domain of a given module. The scientist guides participants in the acquisition of key science content, skills, and values. The course is co-taught by, a science educator who supports participants as they consider pedagogical strategies for bringing science inquiry into their classrooms. The instructors' role is to both facilitate online discussions and serve as mentor and coach.

Each course in our program is specifically for the online environment. The development process is a team effort involving scientists, science educators, online learning specialists, and web developers. A formative evaluation provides weekly feedback from course participants about their learning. With this information, we are able to revise and fine-tune course assignments on the spot.

Those participating in courses further their science knowledge and pedagogical skills through a combination of on-and off-line learning and discussion with course colleagues. They engage in doing science to extend understanding of central concepts and skills, rethink their teaching through analysis of video case studies, and implement ideas into classroom practice as part of their coursework.

A clear eye toward understanding

Our course development builds on the extensive work begun in 1988 by Howard Gardner, David Perkins, and Vito Perrone at Harvard. Project Zero sought to determine what it means to understand something and how we know that understanding is achieved (Wiske 1998, Blythe 1998). Since each course is developed specifically for the online environment, we are able to target understanding within the course structure. Decisions that are commonly left to the instructor, such as when students work in groups, or when they are required to explain their ideas publicly or reflect privately, become part of the course structure. Moreover, the newness of the online learning environment permits us to change the rules regarding not only how the "classroom" works but also how teaching and learning happen. This allows us to keep "understanding" in the forefront as we define the faculty role.

All courses include both science and pedagogical strands; there is a different instructor for each strand. Consequently, it is important to describe what understandings are expected, what students actually do and how the instructors support the development of this understanding.

The science strand

In each course participants are sent a kit of materials so they can set up a lab at home. They explore science concepts through hands-on investigations of common yet complex phenomena. The assignments pose interesting challenges/puzzles to solve. Students collect both qualitative and quantitative data. Science content lectures or informational videos are never used. Students are required to post the results of their investigations and participate in (asynchronous) online

forums with their peers. They post explanations and provide evidence to support their conclusions.

Since the overarching learning goal for each course is to understand science concepts, the role of the instructor as facilitator and coach becomes critical to student success. After reading forum postings, the instructor must make an analysis of the totality. He/she evaluates the level of sophistication (naïve, novice, apprentice, and master) (Wiske 1998) of the posted arguments and explanations, checks for the presence/absence of scientific misconceptions, and devises "interventions" in the form of questions (rather than declarative statements) that force students to confront their misconceptions and/or guide them to the next level of complexity.

"Learning facts is crucial to learning, but learning facts is not learning for understanding! How do we recognize understanding? Through flexible performance criterion. Understanding shows its face when students can think and act flexibly around what they know. In contrast, when a learner can not go beyond rote and routine thought and action, this signals lack of understanding" (Wiske, 1998).

Students are continuously asked to demonstrate their understanding through their posted responses to a variety of performance assessments that are incorporated into each assignment. In addition, at the beginning of each course students are given a complex scenario (the "thought experiment" or case study) designed as an open-ended challenge. The thought experiment incorporates the major science concepts covered in the course. Students are required to write detailed explanations that reveal their understanding of these topics. The thought experiment provides the instructor with valuable information concerning what students actually know about the science topics at the start of the course. Thus the instructor is in a better position to plan individual "paths to success" for participants and evaluate students' progress throughout the course.

The thought experiment is repeated at the end of the course. Consequently, the instructor has written evidence of the change in the student's science understandings with which to determine the final grade.

This attention to the clearly stated "learning goals," individualized performance assessments, and resisting the urge to "pontificate" require instructors to assume a supporting role that "facilitates" and encourages deeper levels of students' learning.

The pedagogical strand

In the pedagogy strand of each course, participants consider specific issues of teaching and learning by first reflecting on their experiences in their science study. Through video of children and teachers, case studies, and reading and discussion, they become familiar with alternative strategies for planning, facilitating, and assessing inquiry-based science. They design plans for trying out ideas in the classroom, carry out their plans, and share their successes and dilemmas with their colleagues. For each course, the aim is to improve what happens in the classroom and to further K-8 student learning through scientific inquiry.

Participants' learning progresses through several stages: awareness, verbal understanding, action in the classroom (Doubler 1991). For example, in the formative assessment course, participants become aware that the learning activities they provide can also serve assessment purposes. As their study proceeds, they come to understand the theoretical underpinnings of this view and the strategies for making assessment integral to learning. Finally, they try out selected strategies in their day-to-day teaching, making these new approaches a natural part of their classroom practice.

In their study group discussions, the instructor keeps a low profile in order to allow participants to support each other's learning. The instructor reads all students' reports and analyzes the thinking of the entire group before responding. This response may summarize the ideas of the group and pose a question that: 1) helps the group bring together opposing views, 2) takes the learning further, 3) presents another perspective, or 4) re-frames what is possible. For example, in one conversation teachers reported that in their online courses they have time to think and that there just isn't enough time in the day for this to happen in their classrooms. The instructor responded, "In your group discussion, you say that the online environment provides time for thinking. Without question, the school day is packed, but if you find that time to think contributes to your learning, wouldn't this be important for your students too? Are there any ways you can think of to get around the problem and create time for your students to think?" (Note that in this response, the instructor doesn't say who raised the problem, rather the problem and the ultimate understanding is owned by the whole study group.)

Once course participants are familiar with alternative strategies, they devise plans for trying them out in the classroom. They submit their plans for review by their colleagues and the instructor, and then revise their plans based on feedback they receive. Since by tradition instructor feedback carries more weight, he or she may "hang back" for a few days to allow the study group members to respond first. The instructor provides a model for how useful, positive feedback is crafted and remains an equal partner in the process, following the same guidelines as the students. The instructor takes the role of coach or advisor asking questions and making suggestions for the next version, and not making a value judgment. The aim is for feedback to move the learning forward (Harlen 2000).

For learning, it's essential that the instructor ensure that the course is a safe place to take risks and to share failures as well as successes. Difficult comments that the facilitator feels may embarrass the participant are submitted privately through email.

The conundrum is that -- while the instructor "facilitates lightly," encourages group discussion, and sometimes hangs back -- when problems emerge for an individual learner, the instructor must act quickly and decisively to help move learning forward. The question that is foremost on the instructor's mind is, "Are participants making changes for the better in their teaching?"

**New Faculty Roles and Expectations**

Our research (Harlen, in press) has examined learning and facilitation in the introductory course, *Try Science,* delivered both online and face-to-face. The intent was not to determine which is better, but to study the nature and extent of learning and articulate the faculty role in each

situation. One instructor taught the course face-to-face, and subsequently on line, and an interview with her yielded some interesting observations.

Since the instructor is not responsible for designing the content in our courses, what exactly is her role? The instructor we interviewed reported two aspects to this new role: focusing on the learning of individuals; and focusing on collaborative learning.

1. Focusing on students' learning included keeping the ideas of the group moving forward and working to bring each student along as part of the group. Since students "talked" as much as they wanted to, the competitive nature of face-to-face classroom participation became a non-issue. She found she was able to help students come together as a group by recognizing their contributions, sending supporting email messages, and encouraging individual students to "speak up." Since on-line student contributions were in print, the details of an individual's thought processes were easier to recognize. She refocused students as necessary and helped them make connections between ideas from current and earlier sessions. She reported her role as facilitator, guide, and coach. Her goal was to help participants to "keep learning". Since the course content was already set out, her energies and attention were devoted to their learning.

2. Focusing on collaborative learning included helping participants to pay attention to each other's contributions and to the important ideas posted by others. In this way, she promoted peer teaching. She took a low profile in the discussion forum and did not respond to individual posts. Thus, the online conversations were driven by student peers. Peer teaching is one of the most pervasive "value-added" aspects of our courses, as reported by students. For this instructor, since the course design required student collaboration, she had to build in collaboration into the face-to-face context. She tried to mimic what occurs naturally online to allow everyone to have a voice. But she found it challenging because she could not be in all places at once and hear what each group discussed.

Online, the community—learner, study group, class colleagues, and instructor—contribute to each individual's building of knowledge. As described by Paloff and Pratt (1999), "Embedded within community building are the active creation of knowledge and meaning and the purposeful empowerment of participants to become experts at their own learning. We have concluded through our work in this medium that the construction of a learning community with the instructor participating as an equal member is key to a successful outcome."

**Implications and New Questions**

The online environment affords an unprecedented opportunity to shift the role of university faculty from "plan and deliver" to "listen and support." The advantage is that students will learn more because we focus on the development of their understanding.

By keeping the development of understanding as the focal point of facilitating on-line courses, major implications arise. With the shift in responsibilities from instructor at the center of the stage, to instructor as coach, an off-stage position, the teaching responsibilities become shared; peer teaching is a serious business, students begin to learn from each other. What is critical at this point is the development of tools to assess and support learning in on-line environments. The

program has developed non-intrusive methods for assessing science learning, for example there is a scientific thought experiment embedded in each course. This is carried out at the beginning and end of the course by the students and pre/post results compared. These instruments take serious development time, but are well worth the effort when you consider the information they yield about student learning.

An interesting question arises: Who is responsible for evaluation of achievement? This has traditionally been another role the teacher has played, but now with distributed responsibility, the evaluation needs distributed properties as well. What should this look like? Can scoring rubrics and criteria really be developed for groups or by groups? If not, can we really say we have distributed the knowledge building? Many questions remain in this exciting new arena.

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